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LV.—*A new African Earthworm, collected by Dr. C. Christy for the Congo Museum; with a Note on its Spermathecæ and Spermatophores.* By H. A. Baylis, B.A.

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A small collection of earthworms made in the Belgian Congo by Dr. Cuthbert Christy, for the Congo Museum at Tervueren, has been sent to the British Museum for examination and report. I am indebted to the Belgian Colonial Administration for permission to describe any new species.

The earthworms, to the number of fifteen specimens, one of which is immature, prove all to be referable to the same species. It belongs to the very large and widespread genus *Dichogaster*, Beddard, of which already upwards of one hundred species have been described from the African continent alone, besides others in Central America, the West Indies, Southern Asia, and elsewhere. The genus is a very well-marked one, but the specific characters, as is natural when the number of closely related species is so large, are very minute. I have not, however, been able to identify the species with any of the previously described African forms; and, as the localities where it was collected are in a comparatively unexplored region, the presumption that this is a new form is not so rash as it might at first sight seem to be.

The worm is said by Dr. Christy to be very common and widely distributed in the region explored by him, *i. e.*, the

Ituri Forest district, between the rivers Welle and Aruwimi. The particular localities mentioned for the syntypes are Medje and Fundi.

I am indebted to Dr. Christy for some most interesting notes on the habits of these worms, from which I take the liberty of quoting some passages. With regard to their habitat and mode of life, he says :—"The worms are found, I think, all through the Ituri forest region, in wet forest. They go down several feet in the red clay, and it requires a lot of digging to get them. It is a common sight . . . to see their red clay 'chimneys' [casts] sticking up amongst the dead leaves. These are sometimes 4 or 5 inches high, and about $1\frac{1}{2}$ inches in diameter ; usually open at the top, but sometimes closed and rounded off . . . I have seen miners at the Bahayru mines using them as tobacco-pipes after baking them in the fire."

When irritated, the worms have the habit, like some other large earthworms, of squirting fluid from the dorsal pores to a considerable distance. The natives avoid touching them on this account, probably thinking them to be poisonous *. With regard to this habit, I again quote Dr. Christy's notes :—"Their squirting propensities only come into play under provocation. Many times I had picked them up with the fingers—which is not easy—before I discovered the habit. Only when I used the rat-tongs did I find out what they could do. The little jets of milky or opalescent and somewhat viscid fluid come simultaneously from all the pores [along each side of the body], and, to be on the safe side, are 10 or 12 inches high, but I think higher. The animal can make a second discharge some minutes later, or even a third." The words in square brackets in this passage are Dr. Christy's, but I think he must have been under a false impression with regard to the pores being on the sides of the body. I cannot find any pores there from which the fluid could have been squirted, and am of the opinion that it must come from the dorsal pores, which are large and conspicuous. With a struggling worm held in the forceps it would be difficult to see exactly where the jets of fluid originated.

On Dr. Christy's suggestion that the specific name should have reference to this power of squirting, I propose to call the new species *Dichogaster jaculatrix*.

* A reference to the effectiveness of the same protective habit in another (unidentified) earthworm in Sierra Leone will be found in my paper on *Aspidodrilus* (Ann. & Mag. Nat. Hist. (8) xiv. 1914, p. 146).

Dichogaster jaculatrix, sp. n.*

External Features.

The specimens vary in length between 18 and 34 cm., and have a diameter of about 10 mm. The number of segments is about 180.

The colour during life, according to Dr. Christy, was a "greenish blue." The cuticle of the specimens in spirit still shows a beautiful green and blue iridescence, the colours being remarkably intense and brilliant. Beneath the cuticle each segment is marked, on the dorsal side, with a purplish transverse band.

The prostomium is small, entering into a slight notch in the anterior border of the first segment. Often, however, it is completely withdrawn into the buccal cavity.

The clitellum commences on segment xiii., and extends back to segment xxii. or xxiii. The "genital area" on the ventral side of the clitellar region is roughly hourglass-shaped in outline, and usually rather deeply sunk. It occupies segments xvii.–xix. The pores of the spermiducal ("prostate") glands are arranged in two pairs, a pair near either end of the genital depression, on segments xvii. and xix. respectively, as is usually the case in this genus. The position of each of these pores is indicated by a single large penial seta, which projects from the body-wall in a very conspicuous manner. These penial setæ (fig. 1) measure 5 mm. in length and 0·13 mm. in thickness. They are entirely smooth, without ornamentation of any kind, and diminish rather suddenly at the tip, which is very slightly hooked.

The male pores lie on segment xviii., between the two apertures of the spermiducal glands on either side. The "seminal gutters," which connect the three pores on either side, are curved inwards towards the middle line, so as to approach each other more closely in the middle than at the ends. No genital papillæ have been observed.

The oviducal pores are quite easily seen on the ventral surface of segment xiv. They are situated rather near the middle line.

The ordinary chætæ (fig. 2) are very small for the size of the worm. The minute size of the chætæ, however, is a feature of almost universal occurrence in the genus. They are, as usual, arranged in four pairs on each segment, beginning with segment iii. They measure 0·8 mm. in

* A specific diagnosis is given on p. 457.

length and 0·045 mm. in thickness. The portion distal to the nodular thickening is much shorter than the proximal portion, and only a very short piece projects beyond the body-wall.

The dorsal pores invariably begin at v./vi. The continuity of the series is always broken by the absence of one or more of the pores in front of the clitellum, as has been remarked in the closely allied forms *D. moorei* and *D. johnstoni* *. The pore at xi./xii. seems to be invariably absent, while of those at x./xi. and at xii./xiii. one or both may also be missing.

Fig. 1. Fig. 2.

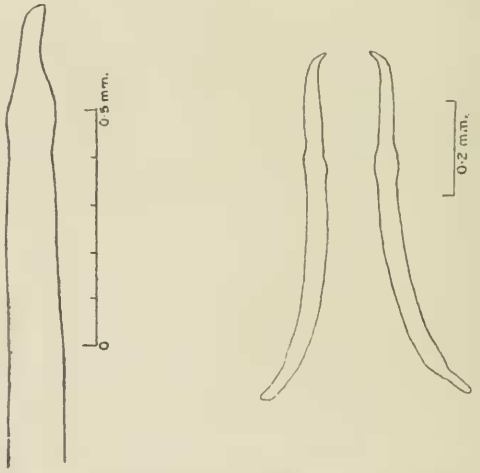


Fig. 1.—*Dichogaster jaculatrix*. Distal end of one of the penial setæ.
Fig. 2.—Ditto. Two ordinary chætæ.

There is little doubt of the normal absence of these pores, as the remainder are, in nearly all cases, well-expanded and easily visible. The pore at xiii./xiv. is sometimes visible, but the rest of the pores belonging to the segments of the clitellum, if present, are greatly obscured, until near the hinder end of the thickened epithelium. From xxi./xxii. or xxii./xxiii. onwards there is a continuous series of pores.

The apertures of the two pairs of spermathecæ occupy their usual positions at vii./viii. and viii./ix., near the mid-ventral line.

* Beddard, Proc. Zool. Soc. 1901, ii. pp. 192, 199.

Internal Anatomy.

In the arrangement of the internal organs of this species there is little that calls for special notice. It agrees closely in almost all points with that usual in the genus.

Some of the anterior septa are wanting, as in other species ; judging from the external segmentation, the missing ones are vi./vii.–viii./ix. The septa anterior to vi./vii. are represented only by muscle-strands connecting the alimentary canal with the body-wall. The first true septum, recognizable as such, is apparently ix./x. This absence of septa makes it difficult to decide to which segments the gizzards and other organs belong. The septa ix./x. and x./xi. are pushed back considerably by the second gizzard, and both join the alimentary canal close together behind it. The two gizzards are not very distinct externally, but the separate muscular thickenings of their walls are easily seen on cutting them open.

There are three pairs of calciferous glands, situated, as usual, in xv.–xvii. The last pair is the largest, and the first the smallest. The glands of the first pair are sometimes of a much whiter appearance than the others, probably owing to the much greater quantity of calcareous crystals contained in them. The ducts of the glands open separately into the alimentary canal.

There is a single dorsal blood-vessel. The last pair of hearts is situated in segment xii.

Concerning the excretory system it is advisable to speak with some reserve. It is probable, however, that, with material specially preserved for histological investigation, the nephridia of this species would prove highly interesting. For the present it will be sufficient to indicate their peculiar arrangement. In the anterior half or two-thirds of the body there is in each segment, midway between the septa which limit it before and behind, a slight transverse mesentery, which seems to run completely round the inside of the body-wall, save for its interruption in the mid-ventral line by the nerve-cord and a slight gap on the dorsal side. On either side of this mesentery there is a series of small, whitish, flattened lobes, each of which may be regarded either as a separate nephridial organ or as a branch of a large compound nephridium. There is a tuft of such lobes, smaller than the rest, near the mid-ventral line on either side. These lobes are connected with a narrow duct which runs, in the thickness of the mesentery, round the segment.

Whether it is continuous all the way round, I am unable to state. This duct, which appears to be ciliated, gives off numerous other very fine, ciliated ducts, at right angles to itself, which pass towards the periphery. In transverse sections through the body-wall very delicate tubes, in whose walls no cellular structure has been detected, can be seen passing out between the bundles of longitudinal and circular muscles to the exterior. I have not succeeded in establishing their connection definitely with the ciliated tubes above mentioned, though it seems probable that such connection exists. The ciliated tubes in the mesentery were visible in whole preparations of nephridia, which were removed together with the mesentery, and mounted in glycerine. The distal ends of the tubes, where they pass between the muscles of the body-wall, could, of course, only be seen by the section method.

These tubes in the body-wall are generally accompanied by fine blood-vessels, while the mesentery is also well supplied with blood-vessels, sending branches to the nephridial lobes.

In the more anterior segments (*i. e.*, in segments a short distance behind the clitellum) I have not succeeded in finding any trace of ciliated nephridial funnels, or any other kind of internal nephridial opening, in spite of the examination of several whole preparations and a considerable number of sections. In the more posterior segments, however, *i. e.*, in about the last third of the body, such funnels certainly exist. In each segment in this region there is, near the ventral nerve-cord, a single pair of nephridial lobes of a much larger size than the rest, and each of these organs has a duct which perforates the septum in front and ends in a well-developed funnel in the preceding segment. In other respects, the arrangement of the nephridia appears to be the same as in the more anterior region.

The external nephridial pores are exceedingly difficult to detect, even in sections, being, apparently, the narrowest of passages between the cells of the epidermis. In spite of careful examination under a comparatively high power, I have been unable to recognize the pores in pieces of stripped-off cuticle, even when taken from the posterior region, where the internal funnels are undoubtedly present. There is a series of minute lozenge-shaped "impressions" in the cuticle, arranged in a single row round each segment, in a line with the little tubular invaginations surrounding the chætæ. These, however, are not pores, but are probably to be compared with the markings said to be the impressions of

groups of sense-cells, and figured by Vejdovsky * in the case of his "*Dendrobæna rubida.*"

The "nephridial lobes," to which reference has already been made, consist of loops of the ciliated nephridial ducts and their accompanying blood-vessels, surrounded by a loose spongy mass of glandular cells, among which are scattered, usually in clumps, numerous small globules of some yellowish-brown substance. They thus seem, on the whole, to resemble the "tufts" of tubules, surrounded by aggregations of peritoneal cells, described by Beddard † in the allied form *Dichogaster damonis.*

It will be seen from the foregoing account that the nephridia in this species, though clearly to be included in the category of "diffuse" nephridia, are arranged on a plan which differs somewhat from the usual type. The appearance of pairing in the nephridial organs of each segment may, of course, be secondary, but it is suggestive of an intermediate condition between the strictly paired and the irregularly diffuse types of excretory system. There may be a network of tubules connecting the nephridia of successive segments, but, so far as my observations have gone, it seems more probable that each segment has its nephridial organs distinct from those of its neighbours.

Genital Organs.—The sperm-sacs consist of two pairs of dorsal prolongations, united by a median ventral space, in segments xi.–xii. The two pairs of testes and the two pairs of voluminous sperm-funnels occupy their usual positions in these segments. The sperm-ducts run for the greater part of their length in the thickness of the body-wall. The ovaries are in segment xiii.

The spermiducal or "prostate" glands are arranged in two pairs. They are large, massive, and solid organs, each consisting, apparently, of a single tube much coiled, and covered by a coat of peritoneum, so that the coils are not visible externally. Each gland gives off a narrow duct which opens close to the penial seta. The epithelium of the glands consists, as in other members of the family, of several layers of flask-shaped cells with very long ducts. The outermost cells are often grouped together in bunches.

There are two pairs of large spermathecæ in the usual position. These organs (figs. 3 & 4) have a stout muscular duct (*D.*) and a sac which is divided by a narrow passage

* Syst. u. Morph. d. Oligochæten, 1884, pl. xv. fig. 13 *a*.

† Quart. Journ. Micr. Sci. n. ser., xxix. 1889, p. 259.

into two chambers, of which the inner, blind, chamber (figs. 3 & 4, *2*) is the larger, and has comparatively thin and little-folded walls. Near the commencement of the duct there are visible, on the outside of the anterior and outer

Fig. 3.

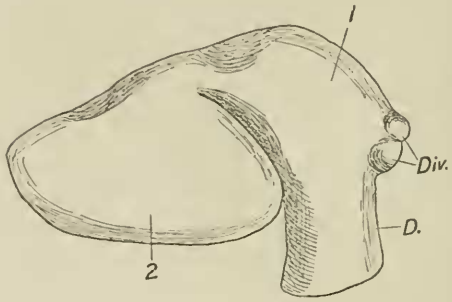


Fig. 4.

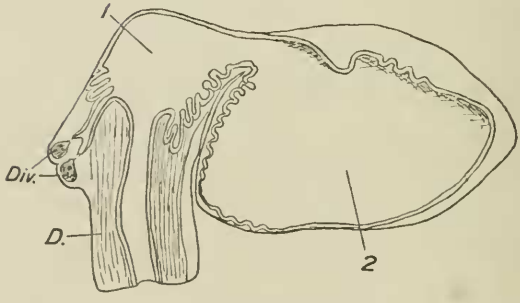


Fig. 3.—*Dichogaster jaculatrix*. The right spermatheca of the posterior pair, viewed from the right side. *D.*, the muscular duct; *Div.*, sperm-containing diverticula; *1*, middle chamber; *2*, terminal sac.

Fig. 4.—Ditto. View of the inside of one-half of a spermatheca, which has been longitudinally divided. The spermatophores, complete and in process of formation, have been removed. *D.*, the muscular duct; *Div.*, sperm-containing diverticula; *1*, middle chamber in which the upper capsule of the completed spermatophore lay; *2*, terminal blind sac.

wall of the spermatheca, from one to three small sessile diverticula (figs. 3 & 4, *Div.*), which are found to contain sperm.

The following is an attempt to summarize, in the form of a brief diagnosis, the chief characteristics of the species :—

Dichogaster jaculatrix, sp. n.

Length (in spirit) 18–34 *cm. ; thickness* 10 *mm. ; number of segments about* 180. *Colour iridescent greenish blue, with a purplish transverse band on each segment dorsally. Prostomium enters slightly into peristomium. Clitellum xiii.–xxii. (xxiii.). Genital area hourglass-shaped, xvii.–xix. Penial setæ smooth, straight, tip narrower and slightly hooked, without ornamentation. Seminal gutters convex inwardly. No genital papillæ. Dorsal pores begin at v./vi. Pores (x./xi.), xi./xii., (xii./xiii.) missing. Septa vi./vii.–viii /ix. absent. Nephridia in the form of a double series of lobes in each segment, supported by a transverse mesentery. Funnels present only in posterior segments. Spermathecæ with* 1–3 *small sessile diverticula visible externally. Spermatophores of characteristic form usually present in spermathecæ.*

Hab. Ituri Forest, Belgian Congo ; in wet forest districts, among dead leaves.

Note on the Spermathecæ and Spermatophores.

The spermatheeæ and their contents in this worm are of peculiar interest, and give rise to questions of a very puzzling nature.

In some other species of *Dichogaster* certain objects have been seen in the spermathecæ by the describers, which have been regarded by them as spermatophores. Our present knowledge of them is mainly due to the researches of Beddard, who has mentioned them in his descriptions of *D.* (*Benhamia*) *moorei* * and *D. austeni* †, and has also devoted a special paper ‡ to the discussion of those seen in the latter species. Michaelsen had also, previously to Beddard's memoir, made a brief reference to structures of a similar kind in *D.* (*Benhamia*) *monticola* and *D. itoliensis* §.

Of these various instances, the structures described by Beddard for *D. austeni* are certainly the most similar to those which I have observed in the present species.

Besides those of *Dichogaster*, the spermatophores of some other genera of earthworms are also of a more or less similar

* P. Z. S. 1901, ii. p. 197.

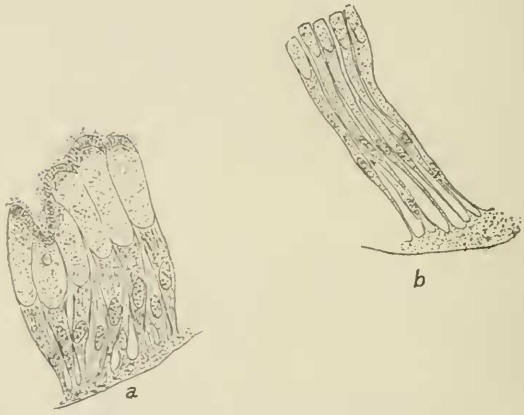
† *T. c.* p. 209. ‡ *T. c.* p. 704.

§ "Die Regenwürmer Ost-Afrikas," in 'Deutsch-Ost-Afrika,' pp. 27 & 28.

form ; I may mention, for example, those of *Stuhlmannia* *, of *Polytoreutus kenyaensis* and *magilensis* †, *Pheretima* ‡, and more especially *Pareudrilus* §.

The spermatheca (figs. 3 & 4) of *D. jaculatrix* consists, as is usually the case, of a thick-walled muscular duct (*D.*), a middle chamber (*1*) with walls of medium thickness, and a large blind terminal chamber (*2*) with comparatively thin and little-folded walls. The walls of the middle chamber are thrown into numerous deep folds and pockets, and the whole organ, including the terminal pouch and the duct

Fig. 5.



Dichogaster jaculatrix. Portions of the epithelium from the inside of the spermatheca : *a*, from the terminal sac : *b*, from the middle chamber. (Cam., oil-imm. $\frac{1}{12}$", oc. 2 Zeiss.)

itself, is lined with an epithelium consisting of tall goblet-shaped glandular cells, which appear to have been in a state of somewhat active secretion.

There are certain differences in the form of these cells in different parts of the organ, probably corresponding to differences in function The cells lining the terminal chamber (fig. 5, *a*) are tall, but not very narrow, and each has a long goblet-like cavity filled with granular secreted matter. The actual distal end of the cell appears to be capped by a thick membrane pierced with perforations. The large nucleus

* See Beddard, P. Z. S. 1901, i. p. 344, and text-fig. 86.
† *Id.* P. Z. S. 1902, ii. p. 200, and text-figs. 52–54.
‡ *Id.* P. Z. S. 1911, p. 412. § *Id.* P. Z. S. 1903, i. p. 219.

is situated near the stalk-end of the cell. In the middle chamber the cells (fig. 5, *b*) are much taller and narrower, and have a very short "cup" at the free end, a much narrower stalk, and a smaller nucleus, situated further from the basement-membrane.

The sperm-containing diverticula (figs. 3 & 4, *Div.*), varying in number from one to three, which project on the anterior and outer surface of the organ, open into the cavity of the middle chamber by a narrow passage a little above its junction with the muscular duct. When more than one of these diverticula or pockets are present, their ducts appear to unite into a single canal of small calibre. There is a muscular coat external to the epithelium lining the pockets, which probably serves for the expulsion of the sperm at the appropriate moment.

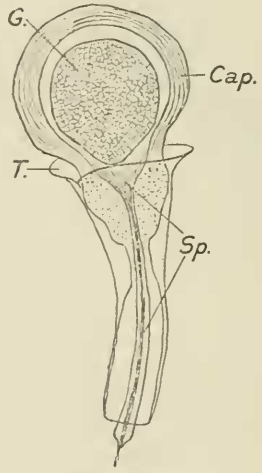
The pockets and their ducts, like the rest of the spermatheca, are lined with a glandular epithelium, the cells of which are similar to those of the middle chamber, but smaller. The contained sperm is massed together into a solid ball—so much so that, on teasing out the mass of sperm from the pocket, I at first imagined that it was enclosed in a membrane. On the examination of sections, however, this does not appear to be the case. It is probable that the spermatozoa were swimming in a fluid medium, which has become solid as the result of preservation. Possibly it is the function of the cells of the epithelium to produce a special fluid for the nutriment of the spermatozoa during their retention in the pocket. If they were "glued" together, in the manner described, during life, it is difficult to understand how they could ever escape from the pockets again, since the way of egress is so narrow.

The muscular duct of the spermatheca seems invariably to contain a tough cuticular lining of peculiar shape. This is, in fact, the lower, trumpet-shaped portion (fig. 6, *T.*) of the "spermatophore," and is almost exactly like that described by Beddard in the case of *D. ansteni*. To the more detailed study of this portion of the apparatus I shall return later. The upper part of the spermatophore consists of a spherical capsule (fig. 6, *Cap.*) of a fibrous or parchment-like consistency, which when fully developed occupies the middle chamber of the spermatheca, and fits into the trumpet-shaped upper end of the cuticular tube. This capsule and the trumpet-shaped tube together make up the complete "spermatophore."

The wall of the upper capsule is composed of numerous layers of some substance which is apparently non-cellular

and structureless, but stains deeply with eosin. It is somewhat opaque, and of a tough consistency, but becomes softened in caustic potash; hence, it seems to me, there is reason to think that it is not chitinous. The contents of this upper portion of the spermatophore consist mainly of a spherical mass (fig. 6, *G.*) of a peculiar refractive substance, which, in the spirit-specimens at least, is extremely hard and brittle. It is composed of numerous granular masses closely pressed together, which can, however, without much difficulty be separated. In general appearance the substance of this mass is not unlike the yolk of an egg. Its separable

Fig. 6.



A complete spermatophore, viewed as a transparent object. *Cap.*, upper capsule; *G.*, solid mass of granular substance; *Sp.*, spermatozoa contained in lumen of lower portion; *T.*, rim of trumpet-shaped tube.

block-like constituents may have been formed as fluid or semifluid globules, and have assumed their present irregular shapes under pressure, the whole mass having become hard and solid as the result of fixation.

In the case of *D. austeni* Beddard has described a very similar spherical capsule, the wall of which is supposed to be chitinous and to be secreted by the columnar cells in the blind terminal sac of the spermatheca. But this capsule is said to be full of sperm, and there is no reference to the

presence of a hard mass of non-cellular substance in it. In *Polytoreutus kenyaensis*, however, the same author describes * the acorn-shaped spermatophores as containing a solid mass of non-staining granular substance, in which are embedded numerous "sperm-ropes," or bundles of spermatozoa (which have themselves been called "spermatophores" in other species). The nature of the solid matrix, the author considers, is "probably identical with that of the substance forming the walls of the spermatophore," and he arrives at the conclusion that this substance is formed by the breaking-down of cells which wander away from the lining of the spermathecal sac.

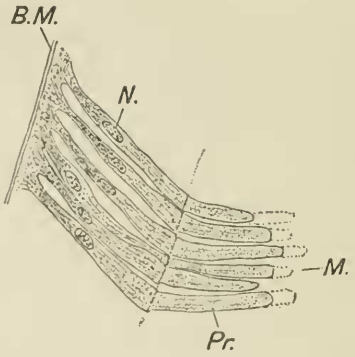
In *Pheretima* the upper and larger end of the pear-shaped spermatophore is said † to be filled with a granular mass, probably composed of broken-down cells, and the sperm contained in the narrower portion is said to be separated from it by a delicate membrane. In attempting to interpret the functions of the granular mass, the author says that its "position . . . at the apex of the spermatophore suggests that it may be of mechanical assistance in expelling the sperm . . . Furthermore, if the case be watertight, the presence of this possibly largely fluid mass may be advantageous to the spermatozoa . . . Its function may be to keep the sperm moist and active." In any case, it seems clear, as the author says, that the granular substance plays some important part in the processes leading to fertilization.

The lower, trumpet-shaped tube of the spermatophore is in intimate connection with the epithelial lining of the duct of the spermatheca, and there seems to be no reasonable doubt that it is formed by the activity of this epithelium, and not out of material introduced from another worm. In *D. austeni* ‡ this portion of the spermatophore is described as having a structureless inner layer, and an outer layer "composed of a parallel series of oblong pieces closely adpressed," which are supposed to correspond to the individual cells of the epithelium. "When the spermatophore is viewed from the outside, these brick-like constituents form a kind of mosaic upon its surface." In *D. jaculatrix* this mosaic-like appearance is also seen, but the "brick-like constituents" in this case appear granular, and they are, I believe, of a different nature. In sections through the duct of the spermatheca, the trumpet-like tube is seen to

* P. Z. S. 1902, ii. p. 200.
† Beddard, P. Z. S. 1911, p. 419.
‡ P. Z. S. 1901, ii. p. 706.

consist of a non-staining, clear, structureless substance, in close contact with the tall columnar cells lining the spermathecal duct. Into its outer portion each of these cells sends a finger-like or clavate protoplasmic process (fig. 7, *Pr.*). Beyond this process there are sometimes visible traces of a cavity in the matrix, from which the process has evidently just been withdrawn, and which is doubtless filled with secreted matter which has not yet become solidly fused with the rest of the wall of the tube. When the spermatophore is dissected out from the spermathecal duct, and the epithelium of the latter teased off with needles (an operation which it is not easy to perform completely, owing to its very

Fig. 7.



Portion of the lining epithelium of the duct of the spermatheca. *B.M.*, basement-membrane; *M.*, secreted matrix (wall of trumpet-shaped tube); *N.*, nucleus; *Pr.*, protoplasmic processes secreting the substance of the tube. (Cam., oil-imm. $\frac{1}{12}$", oc. 2 Zeiss.)

close adherence), some of the protoplasmic processes are torn out, but the majority of them are broken off from their cells and remain embedded in the matrix of secreted matter. It is these processes, I believe, which give the wall of the spermatophore its mosaic-like appearance when viewed from the outside. Beddard considered that this tube was probably of chitinous nature; but, owing to its being considerably softened and altered by caustic potash, I am inclined to think it is of a less hard material.

The trumpet-like tube is filled with slightly eosinophilous matter of a yellow colour and a stratified appearance, down the centre of which there is a very narrow lumen, containing

sperm (fig. 6, *Sp.*). This lumen is, I think, open at its lower extremity. The yellow matter and sperm were present in the spermatheca of which serial sections were cut, although no upper capsule was found in the middle spermathecal sac. The outer extremity of the trumpet-like tube was also blocked by a mass of homogeneous substance, having much the appearance of yolk. This substance differs somewhat, however, from that of the mass contained in the upper capsule, when this is present, for the latter is much more granular.

In a spermatophore both parts of which, *i. e.*, both the trumpet-like tube and the upper capsule, were fully formed and in contact, the yellow stratified matter within the tube was found by the section method to be continuous with the wall of the upper capsule, but stained much less deeply. The sperm-containing lumen in this yellow matter was also in communication with the cavity of the capsule, the lower part of which also contained a small quantity of sperm, clinging to its walls.

It will probably be impossible to arrive at any definite conclusions regarding the history and ultimate fate of the "spermatophores" in these worms, until some good observer furnishes us with an account of their breeding-habits. Viewed from a structural standpoint, the spermatophores, if such they are, are most interesting and puzzling. It is very difficult to understand what can be the advantage of enclosing the sperm in such an elaborately-formed case, and not less so to trace the probable manner of its formation.

The only point which appears to me to be now settled almost with certainty, is that the lower, trumpet-like tube of the spermatophore is actually *secreted*, and not merely *moulded*, by the epithelium of the spermathecal duct. Beddard has already reached the conclusion that in *D. austeni* it is moulded at least, if not really secreted, by this duct, but with the reservation that the material might have been derived from the spermiducal glands of another worm. The evidence, in the present case, of the protoplasmic processes of the cells of the duct, extending as they do into the edges of the secreted matter, seems to me to place this question, with regard to *D. jaculatrix* at least, almost beyond doubt.

The origin of the other parts of the spermatophore, and the order of formation of all the parts, are, however, still very doubtful. From the glandular nature of the cells lining both divisions of the spermathecal sac, it would seem almost certain that they must play some part in the formation of the apparatus. I am inclined to believe that they are

concerned in the secretion of the substance which forms the wall of the upper capsule; but whether any of this substance is derived from the spermidueal glands of another worm during copulation, appears to me still open to question.

In the spermatheca which I have examined by means of serial sections, the terminal chamber contained two or three bodies of somewhat irregular shape, with thick, stratified, strongly eosinophilous walls, and with their cavities filled with more or less hard granular matter. In fact, there can be no doubt that these bodies correspond exactly with the part of the fully-formed spermatophore which I have called the "upper capsule." It is not easy, however, to account for the mass of granular matter within the capsule. It appears to me not unlikely that this, if anything, is what is derived from the spermidueal glands, and that it is the substance which acts as a stimulus to the epithelial cells of the spermatheca, and causes them to throw out their secretion and so surround it with the successive layers of matter which form the capsule. This, however, is merely suggested as a possibility; it is not incompatible with the appearance of the granules or globules of secretion seen in the cells of the spermidueal gland and the granular residual matter also found in the terminal chamber of the spermatheca. In any case, it seems doubtful whether either the granular mass or the capsule can be derived from broken-down epithelial cells of the spermatheca, since I have been unable to find any cells, recognizable as such, which had wandered off into the cavity of the sac.

Probably the formation of the capsule is not completed until it has been transferred from the terminal chamber into the middle chamber of the spermatheca. Here, it may be supposed, the yellow stratified matter is formed, which lines the trumpet-shaped tube, and the lower end of the capsule is fused with this. How the spermatozoa are introduced into the apparatus is very doubtful. It may be that just before the fusion of the two portions a contraction of the sperm-diverticula, or of one of them, takes place, by means of the muscles of their walls, and the sperm is driven down the duct and into the required position near the mouth of the trumpet-shaped tube, whence it finds its way into the spermatophore.

Finally, the mass of homogeneous substance blocking the outer end of the spermathecal duct has to be accounted for. It seems to me probable, though by no means certain, that this is a plug formed by the coagulation of some secretion, after the act of copulation is complete. Beddard has

suggested in the case of *Stuhlmannia* * that the thickened plug-like end of the spermatophore is derived from the spermiducal glands of the other worm. I think that in the present case a similar explanation may be applicable, and that this substance may be either a product of the spermiducal glands or a mucoid secretion of the skin of the clitellar region, and that it may serve a useful purpose in retaining the recently-injected sperm within the spermatheca, until it is stored in the special pockets provided for it, and also as a plug for the completed spermatophore.

My thanks are due to my friend and colleague, Dr. W. T. Calman, for some useful suggestions and criticisms while working at the subject of this paper.

LVI.—*List of Mammals (exclusive of Ungulata) collected on the Upper Congo by Dr. Christy for the Congo Museum, Tervueren.* By Oldfield Thomas, F.R.S.

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In the 'Annals' for last August † I published a few of the more striking novelties from the fine series of Mammalia brought home from the Congo by Dr. Cuthbert Christy, who had been employed by the Congo Museum to make a collection for them on the Ituri and Welle, and, by request of the Belgian authorities, I now give a list of all the species obtained by him, with the exception of the Ungulates.

Such a list is always valuable for zoo-geographical reasons, and Dr. Christy's fine collection so supplements those made in the same region by Emin Pasha, the Alexander-Gosling Expedition, and the members of the Ruwenzori Expedition, as to make the complete list a very long one.

In a general way, there is a great uniformity in the Mammal life from the Cameroons to Uganda, as might be expected from the uniform nature of the country, but in a few cases there is enough local difference to authorise the distinction of special subspecies for the Upper Congo forms.

In all, Dr. Christy's collection contains 74 species and subspecies, of which 10 have proved to need description

* P. Z. S. 1901, i. p. 351.

† Ann. & Mag. N. H. (8) xvi. p. 146 (1915).